

Instructions For



# 16K Memory Expansion

Cartridge for  
the VIC-20®

CRAM16/IB (4 83)

® VIC-20 is a registered trademark of Commodore, International



cardco, inc.

313 Mathewson • Wichita, Ks 67214



"CARDAM/16" - INSTRUCTIONS

GUARANTEE

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For as long as this product is owned by its original owner, CARDCO, Inc. will repair or replace any defective parts or the entire unit if it should become inoperative due to a defect in manufacture or materials, providing the unit is returned to CARDCO, Inc. in undamaged condition with proof of purchase (purchase receipt).

This product was developed by:

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THIS WARRANTY IS LIMITED TO LIABILITY FOR THE PRODUCT ONLY, AND CARDCO, INC. WILL NOT BE RESPONSIBLE FOR DAMAGE TO OR LOSS OF ANY ASSOCIATED HARDWARE OR SOFTWARE CAUSED BY THE USE AND/OR MISUSE OF THIS PRODUCT.

WARNING  
\*\*\*\*\*

NEVER ATTEMPT TO INSTALL OR REMOVE THE  
"CARDAM/16" WITHOUT FIRST TURNING OFF THE  
VIC-20 POWER SWITCH.

DON'T FORGET THE RULES:  
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NOTE: Within the program listings in this  
manual these codes are used to make  
the program listings more readable.

LISTING CODES:

<CU>	CURSOR UP
<CD>	CURSOR DOWN
<CL>	CURSOR LEFT
<CR>	CURSOR RIGHT
<HM>	CURSOR HOME
<SC>	SCREEN CLEAR
<RV>	REVERSE ON
<RO>	REVERSE OFF
<ID>	INSERT KEY or DELETE KEY
<CC>	COLOR CHANGE

TURN OFF YOUR VIC WHEN CHANGING CARTRIDGES.

YOU CAN'T PUT TWO THINGS IN THE SAME PLACE.

WHEN ALL ELSE FAILS READ THE INSTRUCTIONS.

NOTICE:

This is the most accurate information available we have at this time. As new games and utilities become available they may require different memory locations than those listed here. With some creativity on your part you should be able to utilize them with most of the newly introduced VIC equipment.

TABLE OF CONTENTS  
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INTRODUCTION & INITIAL SET UP	PAGE	4
VIC-20 MEMORY ALLOCATION	PAGE	6
VIC-20 MINI-MEMORY MAP	PAGE	8
THE VIC-20 MOVING SCREEN	PAGE	10
VIC-20 SCREEN MAPS	PAGE	12
"CARDAM/16" OPERATION	PAGE	13

APPENDIX

SPECIAL TERMS	PAGE	A1
SCREEN RELOCATION PROGRAM	PAGE	A3
THE USE OF RAM IN BLOCK # 5	PAGE	A4
SCREEN SWAP PROGRAM	PAGE	A6
PROGRAM SWAP PROGRAM	PAGE	A8
MEMORY MAP PROGRAM	PAGE	A10
MEMORY CHECK PROGRAM	PAGE	A12
GAME SIMULATOR PROGRAM	PAGE	A16
CARTRIDGE ASSIGNMENTS	PAGE	A17

Well, you bought it! What do you do with it?  
\*\*\*\*\*

The first thing you will need to do is put the board into your VIC. You should have no problem. However, if you do please feel free to call our office at (316) 267-6525 between the hours of 1 PM and 5 PM CST.

To start you off in the right direction, use a ball point pen and turn on the RAM 1 - BLOCK 1 and the RAM 2 - BLOCK 2 dip switches on the "CARDRAM/16". (refer to the diagram on page # 14). Then, turn off your VIC-20 and:

\*\* If you are not using an expansion board:

Plug the "CARDRAM/16" into the back of your VIC into the same place you would normally plug a game cartridge. Plug the cartridge in with the switches up, center the board carefully then firmly push it into position.

\*\* If you are using an expansion board:

Remove all other cartridges from the board, orient the "CARDRAM/16" so that the switches are facing the computer, and then plug the "CARDRAM/16" into the slot on the board closest to the computer (so you can get at the switches for use when needed). If your expansion board has switches be sure that the switch that controls that slot is turned on, or on our "CARDBOARD/3s" or our "CARDBOARD/6" be sure that dip switch # 7 is in the on position.

PROGRAMMER'S AID:

This cartridge resides in BLK 3 and will require that you not use RAM in BLK # 3 or VIC-MON.

VIC-MON MACHINE LANGUAGE MONITOR:

This cartridge resides in BLK 3 and will require that you not use RAM in BLK # 3 or Programmer's Aid.

HES MON MACHINE LANGUAGE MONITOR:

This cartridge resides in BLK # 5.

HES WRITER WORD PROCESSOR:

This cartridge resides in BLK # 5.

QUICK BROWN FOX WORD PROCESSOR:

This cartridge resides in BLK # 3.

VIC-TREE PROGRAMMERS UTILITY CARTRIDGE:

This cartridge uses both BLK # 3 and BLK # 5.

\*\*\*\* INTERNAL DIP SWITCH #4: Locates the RAM in memory BLK 1. This will give you 11775 BYTES FREE.

\*\*\*\* INTERNAL DIP SWITCH #3: Locates the RAM to memory BLK 2. To be used by basic this block will require an 8K RAM in BLK # 1. This will give you 19967 BYTES FREE.

\*\*\*\* INTERNAL DIP SWITCH #2: Locates the RAM to memory BLK 3. To be useable by basic you must have 8K RAMs in BLK 1 & BLK 2. This will give you 28159 BYTES FREE. This will also prevent you from using VIC-MON or Programmer's Aid

\*\*\*\* INTERNAL DIP SWITCH #1: Locates the RAM to memory BLK 5. It is not useable for basic programming. RAM cannot be used in BLK # 5 if you are using Super Expander or auto-start game cartridges

#### COMMODORE 16k RAM EXPANSION:

This unit contains two separate 8k RAM groups that are permanently assigned to block # 1 and block # 2.

#### PLUG-IN GAMES:

All plug-in games that start up automatically will be addressed to BLK # 5. Some games may also use combinations of several other blocks. Trial and error will help you determine where a particular game resides, because we cannot possibly give you all that information in this manual.

Now turn on your computer and see if the start up message on your screen includes the number "19967 BYTES FREE." If the number does not equal this number repeat the steps outlined above exactly as stated and check the number again.

If you cannot get past this step please contact your dealer or call our customer service department at (316) 267-6525 between the hours of 1 PM and 5 PM C.S.T. Mon-Fri.

Once you have completed this step you may want to type in and run the MEMORY TEST PROGRAM as listed on page # A12.

If you are not using an expansion board of any kind a lot of the following information will be of only passing interest, but you should read it anyway because it has a wealth of information about your computer and how it operates.

SOME VALUABLE TECHNICAL INFORMATION  
\*\*\*\*\*

It is a law of nature that you cannot have two things in the same place at the same time. This is also true of memory in the VIC-20. You cannot have two things in the same memory location at the same time.

Everything that you plug into your computer takes up space in the computer's memory map. (Refer to the mini-memory-map on page 8) The "CARDAM/16" requires two memory blocks and if you already have something in one of those blocks neither of the items will function correctly.

O.K. So how do you find out what cartridges go in which block? Turn to the appendix at the rear of this booklet for a listing of some of the cartridge assignment locations.

A little trial and error won't hurt. The VIC-20 won't blow up if you put in the wrong cartridges, all that will happen is that when you turn the power on your VIC will lock up and you won't be able to use it until you turn it off, correct your errors and apologize profusely.

There are seven blocks or areas of memory that are not used by the internal workings of your VIC-20. These blocks are made available to the user through the memory expansion port (remember, the place where you plug in games, etc.).

TO THE BEST OF OUR KNOWLEDGE WHAT GOES WHERE  
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THIS SECTION IS DESIGNED TO TELL YOU WHAT RAM BLOCKS ARE USED BY OTHER CARTRIDGES SO AS TO AVOID CONFLICTS WITH THESE CARTRIDGES.

3K RAM EXPANSION:

Goes in RAM 1, RAM 2, & RAM 3. No special requirements; its access is automatic. But, remember...it will not add up in the bytes free total in the power up message with the "CARDAM/16" installed.

SUPER EXPANDER:

Same as 3k RAM, and it also occupies BLK # 5 as an auto start ROM, so it automatically comes on line when you turn on your VIC-20. Use of this cartridge will prevent you from using RAM in BLK # 5. It also will subtract 136 bytes from your start up bytes free message if you have 8k or more of RAM added to your VIC.

COMMODORE 8K RAM EXPANSION:

There is an internal dip switch inside the case of each of these cartridges. Refer to the instruction sheet that comes in the cartridge box. This internal switch group can have only one switch on at a time.



```

100 REM GAME SIMULATOR BY BRECK RICKETTS
110 REM 16K MEMORY MUST BE 15 BLOCKS 2,3
120 M=16384:PRINT"(SC){CD}{CR}{CR}{CR} GAME
SIMULATOR"
130 IFPEEK(40964)<>650RPEEK(40965)<>48THEN
PRINT"(RV){CD}{CC}{CR}NO GAME IN BLOCK 5{CC}"
:END
140 POKE16384,76:IF PEEK(16384)<>76THENPRINT"
{CD}{CR}{RV}{CC}NO RAM IN BLOCK 2{CC}":END
150 POKE24576,76:IF PEEK(24576)<>76THENPRINT"
{CD}{CR}{RV}{CC}NO RAM IN BLOCK 3{CC}":END
160 READA:IFA=-1THEN180
170 POKEM,A:M=M+1:B=B+A:GOTO160
180 IFB<>12292THEN PRINT"{SC){CD){CR){RV){CC}
BAD DATA STATEMENTS{CC}":END
190 PRINT"{SC){CD){CR}SYS {RV}16384{RO} TO
SAVE"
200 PRINT"{CD){CR}SYS {RV}16453{RO} TO LOAD"
210 PRINT"{CR}WITH NO NAME"
220 PRINT"{CD){CR}SYS {RV}16460{RO} TO LOAD"
230 PRINT"{CR}WITH NAME"
240 PRINT"{CD){CR}POKE 17000,X FOR NAME{CD}
{CD}"
250 DATA169,0,133,0,168,133,2,169,160,133,1,
169,96,133,3,177,0,145,2,230,0,230,2,208
260 DATA246,230,3,230,1,165,1,201,192,208,236
,169,0,133,0,169,96,133,1,162,0,160,128,169
270 DATA1,133,186,169,104,133,187,169,66,133,
188,169,1,133,183,169,0,32,117,246,96,169
280 DATA0,133,183,76,88,64,169,104,133,187,
169,66,133,188,169,1,133,183,169,1,133,186
290 DATA133,185,162,0,160,96,169,0,32,66,245,
96,-1

```

The seven memory blocks are:

- RAM 1) These three blocks are usually
  - RAM 2) treated as one unit. Each is 1k in
  - RAM 3) size and they are located below the
- internal 5k of RAM that is included with the VIC-20. Increases memory to 65000+ BYTES FREE total.
- BLK 1) This is the first 8k expansion area.
  - Increases RAM to 110000+ BYTES FREE.
  - BLK 2) This is the 2nd 8k expansion area.
  - Increases RAM to 190000+ BYTES FREE.
  - BLK 3) This is the 3rd 8k expansion area.
  - Increases RAM to 280000+ BYTES FREE.
  - BLK 5) This is the last 8k expansion area.
  - Will not increase user basic RAM.

The "CARDAM/16" may occupy any two of the BLKs listed above as 8k expansion areas.

NOTE: Refer to mini-memory-map, figure #2.

MINI MEMORY MAP -----			
DECIMAL ADDRESS	HEX ADDRESS	INTERNAL VIC MEMORY RAM/ROM LOCATIONS	ACCESSED VIA MEMORY EXPANSION PORT
0000 TO 0928	\$0000- \$033B	ZERO PAGE & WORKING RAM	
0928 1023	\$033C \$03FF	CASSETTE BUFFER	
1024 4095	\$0400 \$0FFF		3K EXPANSION RAM RAM#1,RAM#2,RAM#3
4096 8191	\$1000 \$1FFF	INTERNAL USER RAM & SCREEN RAM	
8192 16383	\$2000 \$3FFF		8K EXPANSION RAM BLK # 1
16384 24575	\$4000 \$5FFF		8K EXPANSION RAM BLK # 2
24576 32767	\$6000 \$7FFF		8K EXPANSION RAM BLK # 3
32768 36863	\$8000 \$8FFF	CHARACTER GENERATOR ROM	
36864 40959	\$9000 \$9FFF	VIC CHIP, I/O & COLOR RAM	
40960 49151	\$A000 \$BFFF		8K EXPANSION RAM BLK # 5
49152 65535	\$C000 \$FFFF	KERNAL ROUTINES AND BASIC INTERPRETER ROM.	

FIGURE # 2  
\*\*\*\*\*

(SYS 64802 for those who do not have a reset button) then use your computer like the cartridge is a ROM and follow the same instructions for using it. (ie. sys 6\*4096 to enable VIC-MON).

If the cartridge was a block # 5 cartridge you must switch off RAM1 BLOCK # 3 and switch on RAM1 BLOCK # 5. Then press the reset button (or SYS 64802), if the cartridge was designed as an auto-start type you should be under way, otherwise follow the cartridge's directions to enable it.

We know some games won't run, some run once and then bomb (OMEGA RACE) and most run just fine. TRIAL AND ERROR is your only hope.

Just for your information, making copies of a program you do not own is against the law. So is giving copies of programs you own to persons who do not own an original of the same program. Therefore, use this program for your personal benefit and educational advancement.

NOTICE: If you want to save to the disk these routines will not work.

If you get a BAD DATA ERROR you typed in some of the data statements wrong. If not your screen will display your options. At this point you will wish to save the program. If you intend to put more than one program on a tape you can save each program with a name. To exercise this option simply POKE any number from 0 to 255 into location 17000, this becomes the program name and it will show up as the ASCII character of the number you chose (65=A, 66=B, etc.)

Now, type SYS 16384 to save the cartridge. Your program will now be saved to the tape.

In the case of a block # 3 cartridge follow the instructions as above except that you should not enable (turn on) the cartridge you want to save until after you load and run the program and then only when you get to the SYS prompts should you then turn off the RAM1 BLOCK # 3 switch on the "CARDAM/16" and then turn on the switch for the cartridge you wish to save. Now to save the cartridge type SYS 16419.

When ever you want to use the program now all you need to do is be sure that you have your "CARDAM/16" switches set to RAM1 BLOCK # 3 and RAM2 BLOCK # 2. Load and run the game simulator, then at the SYS prompts, POKE 17000, the program name value (0 to 255). Then SYS 16460 to load a named program, or SYS 16453 to load the next program on the tape.

If the cartridge was originally in block # 3 you are ready to go. You can re-assign RAM2 to BLOCK # 1 and press reset

As you may have noticed, the 8k Blocks are numbered 1, 2, 3, 5. What happened to #4 ??? Well, Commodore decided to use that location for some internal workings, and thereby made it unavailable for us to use. This also puts BLK 5 in an awkward position, because basic only "sees" memory that is in a continuous string. BLK 5 cannot be used for basic programming because it is separated from the rest of the RAM blocks by BLK 4. But not to worry -- if you put 8k of RAM there, it is still useable as a storage area for machine language program as well as storage for various data. When data is stored up there, it is very safe, because basic cannot overwrite it. In fact, the only way to get at it is with a "SYS" command or a "PEEK" or "POKE". More on that later.

If you have an 8k RAM in BLK 1 and a 3k or or super expander in RAM 1, RAM 2, and RAM 3 memory areas, these RAM blocks also become unuseable for basic programming because it is separated from the rest of basic ram by the screen ram (the area of ram the VIC-20 uses to store the information on the screen). And it, just like BLK #5, becomes useable for machine language programming and storage of data only because it is not in a continuous line with the rest of the RAM memory that basic uses. (The screen is now between the 3k area and the rest of basic RAM)

Have I got you confused yet?

See if this helps.

THE MYSTERIOUS MOVING SCREEN  
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Now is the time to tell you about "THE MYSTERIOUS MOVING SCREEN"! You may have been warned by some (tape-based) software suppliers that THIS PROGRAM WILL ONLY RUN ON VIC-20's WITH NO ADDITIONAL MEMORY INSTALLED Or you may have tried to load a program from a tape when you had your 16k RAM cartridge in place and found it didn't work, or had some really weird goings-on happening on the screen. The reason is that when you put an 8k or 16k RAM in the VIC's BLK #1 location and turned on the VIC, the screen RAM is moved to a new position. (Refer to figure 3 to see what happens.)

A well written program will not be affected by the amount of memory you have, but for those of you who own some poorly written programs, and for those of you who want to write good programs we offer these solutions to the problem.

GAME SIMULATOR  
\*\*\*\*\*

At times it would be nice to be able to save a game or utility cartridge from its cartridge format to tape format. This program will allow you to save a cartridge from BLOCK # 5 or BLOCK # 3 to tape and then reload the program and run it. Be aware however that some cartridges use protection schemes that preclude this process but it will work on most cartridges. Also, some cartridges use both blocks 3 & 5, these will require a little more work but they can be used as well. First let's cover a block # 5 cartridge save.

To use this program first type in and save the program. Now you will need an expansion board like our "CARDBOARD/3s". Turn off your VIC, plug the cartridge you want to save into the board being sure that the slot that this cartridge is in is turned off. Set the switches on the "CARDAM/16" to assign RAM1 to BLOCK # 3 and RAM2 to BLOCK # 2 and plug it into the expansion board in a position that will allow you to get at the switches as you will need to change them later, and be sure that the slot this cartridge is in is turned on.

Now turn on your VIC, you should get the power up message of 3558 BYTES FREE. Turn on the switch or switches that will turn on the slot that the cartridge you wish to save is in. Load the program you saved earlier and run it.

```

100 REM MEMORY CHECK BY BRECK RICKETTS
110 REM 16K OF RAM SHOULD BE IN BLOCK 1 AND 2
120 PRINT "{SC}{CD}{CR}{CR}{CR} 16K MEMORY
CHECK{CD}":POKE8192,76:POKE16384,76
130 IF PEEK(8192)<>76 THEN PRINT "{CR}{CR}{RV}
{CC}NO RAM IN BLOCK 1{CD}"
140 IF PEEK(16384)<>76 THEN PRINT "{CR}{CR}{RV}
{CC}NO RAM IN BLOCK 2{CD}"
150 PRINT "{CD}{CR}{CR}{CR}RUNNING CHECK"
155 M=828
160 READ A:IFA=-1THEN180
170 POKEM,A:M=M+1:B=B+A:GOTO160
180 IF B<>9738THEN PRINT "{CC}{RV}{CD}{CR}{CR}
ERROR IN DATA{CD}{CL}{CL}{CL}{CL}{CL}{CL}{CL}
{CL}{CL}{CL}{CL}{CL}STATEMENTS{CC}":END
190 SYS828:A=PEEK(2)+PEEK(3)*256
195 IFA=0THENPRINT "{CC}";:GOTO200
196 PRINT "{CC}";
200 PRINT "{RV}{CD}"A"(R)ERRORS IN 2"
210 PRINT "{CD}{CR}{CR}{CR}{CR}{CR}PASSES OR"
220 PRINT "{CD}{RV}"A/2"(R)ERRORS PER PASS
{CC}":END
230 DATA120,169,0,133,0,168,133,2,133,3,169,
32,133,1,169,170,145,0,177,0,201,170,208
240 DATA45,230,0,208,242,230,1,165,1,201,96,
208,234,169,0,133,0,169,32,133,1,169,85
250 DATA145,0,177,0,201,85,208,21,230,0,208,
242,230,1,165,1,201,96,208,234,88,96,234
260 DATA32,141,3,76,84,3,32,141,3,76,114,3,
230,2,208,2,230,3,96,0,-1
270 REM LINE 130,140,196, CC=RED
280 REM LINE 180 CC=RED,BLUE
290 REM LINE 220 CC=BLUE
300 REM LINE 195 CC=GREEN

```

SOLUTION #1. There is a program at the end of this booklet which will put the screen back at its original position and relocate basic to start above the screen RAM area. This will allow you to use up to 24k of RAM for basic programming with these poorly written programs; and it has the side benefit of protecting the RAM area below the screen from being overrun by basic, and that is the area where you store the special characters you design for your own games. Or you can store machine language sub-routines there without fear of destruction or using any of basic's memory area.

SOLUTION #2. Additionally, there is a set of statements that will allow you to preprogram any programs that you write to run in any VIC memory configuration:

Make this one of your first program lines:

$$S = 4 * (\text{PEEK}(36866) \text{ AND } 128) + 64 * (\text{PEEK}(36869) \text{ AND } 112) : C = 37888 + 4 * (\text{PEEK}(36866) \text{ AND } 128)$$

You can now peek or poke to the screen (no matter where it is) by using the variable S as the start of the screen memory locations and C as the start of the color memory locations. For example the third character location on the third line would be S+68. (S=start of screen, and 68 is the 3rd line because each line is 22 characters long so 3\*22 = 66, and the 3rd character adds 2 because the first position is the 0, the second position is 1 etc.)

THE MYSTICAL MOVING SCREEN

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VIC-20 VIDEO RAM MEMORY MAP

-----		-----	
MEMORY LOC	WITH LESS THAN	WITH 8K OR MORE	
HEX DEC	8K OF RAM	OF RAM ADDED	
-----			
\$0400 1024	START OF BASIC WITH 3K EXP. RAM.		
\$1000 4096	START OF BASIC WITH NO EXP. RAM.	START OF SCREEN MEMORY	
\$1200 4608		SYART OF BASIC	
\$1E00 7680	START OF SCREEN		
\$1FFF 8191	END OF MEMORY	END INTERNAL RAM	
\$3FFF 16383		END BLK # 1 RAM	
\$5FFF 24575		END BLK # 2 RAM	
\$7FFF 32767		END BLK # 3 RAM	
\$9400 37888		START COLOR RAM	
\$9600 38400	START COLOR RAM		

FIGURE # 3

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MEMORY CHECK

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This program will test all RAM memory located in memory BLOCK # 1 and BLOCK # 2. This is an easy check of a complete 8k or 16k memory cartridge. It will inform you of the presence of either 8k or 16k and any faulty memory locations will show up as errors on the display.

This is a two pass test that loads and checks every location twice. For a more demanding test you can change the END in line 220 to a GOTO 190. This will create a loop that will test and display memory until you stop it with the RUN/STOP key. This will test the RAM cartridge constantly and allow you to watch the display for any errors. A normal error rate for a good RAM cartridge should be less than one error in every 10,000 passes. The loop takes less than one second so we would expect less than one error every three hours. That is an error rate of less than .000008%.

```

10000 REM MEMORY MAP BY BRECK RICKETTS
10010 Y$="(CD)(CR)(CR)(CR)(CR)(CR):Z$="0077777777":PRINT"(SC)(CC)";
10020 PRINTY$"$C0"Z$
10030 PRINTY$"$A0"Z$
10040 PRINTY$"$80"Z$
10050 PRINTY$"$60"Z$
10060 PRINTY$"$40"Z$
10070 PRINTY$"$20"Z$
10080 PRINTY$"$1E"Z$
10090 PRINTY$"$12"Z$
10100 PRINTY$"$10"Z$
10110 PRINTY$"$04"Z$
10120 PRINTY$"$00"Z$
10130 PRINT"(HM)(CD)";
10140 Z5=PEEK(43)+PEEK(44)*256;Z6=PEEK(55)+PEEK(56)*256
10150 Z1=40964;Z2=160;GOSUB10340
10160 PRINTY$"(CC)1/O ";
10170 Z1=24582;Z2=96;GOSUB10340
10180 Z1=16421;Z2=64;GOSUB10340
10190 Z1=8280;Z2=32;GOSUB10340
10200 Z7=4*(PEEK(36866)AND128)+64*(PEEK(36869)AND112)
10210 IFZ7=7680THENPRINTY$"(CC)SCREEN":GOTO10230
10220 PRINTY$"(CC)BASIC"
10230 PRINTY$"(CC)BASIC"
10240 IFZ7<>7680THENPRINTY$"(CC)SCREEN":GOTO10260
10250 PRINTY$"(CC)BASIC"
10260 REM
10270 POKE2000,76:IFPEEK(2000)=76THEN10290
10280 PRINTY$"(CC)NONE":GOTO10310
10290 IFZ5<1100THENPRINTY$"(CC)BASIC":GOTO10310
10300 PRINTY$"(CC)RAM ";
10310 PRINTY$"(CC)IRAM"
10320 GETZ$:IFZ$=""THEN10320
10330 PRINT"(CC)(SC)":RETURN
10340 Y$="(CD)(CR)(CR)(CR)(CR)(CR)(CR)(CR)(CR)(CR)(CR)(RV)"
10350 IFPEEK(Z1)=65ANDPEEK(Z1+1)=48THENPRINTY$"(CC)GAME":RETURN
10360 POKEZ1,76:POKEZ1+1,76:IFPEEK(Z1)=76ANDPEEK(Z1+1)=76THEN10380
10370 GOTO10400
10380 IFZ1<26THENPRINTY$"(CC)BASIC":RETURN
10390 PRINTY$"(CC)RAM ":RETURN
10400 IFPEEK(Z1)<>220RPEEK(Z1+1)<>222THENPRINTY$"(CC)CART":RETURN
10410 IFPEEK(Z1)=222THENPRINTY$"(CC)NONE"
10420 RETURN
10430 REM LINE 10010,10160,10310,10330 CC=BLUE
10440 REM LINE 10210,10240,10350 CC=RED
10450 REM LINE 10220,10230,10250,10290,10300,10380,10390 CC=GREEN
10460 REM LINE 10400 CC=PURPLE
10470 REM LINE 10280,10410 CC=CYAN
10480 REM LINE 10010 THE 'MUSHROOM' IS A SHIFT C

```

"CARDAM/16" FUNCTIONS AND OPERATIONS  
 \*\*\*\*\*

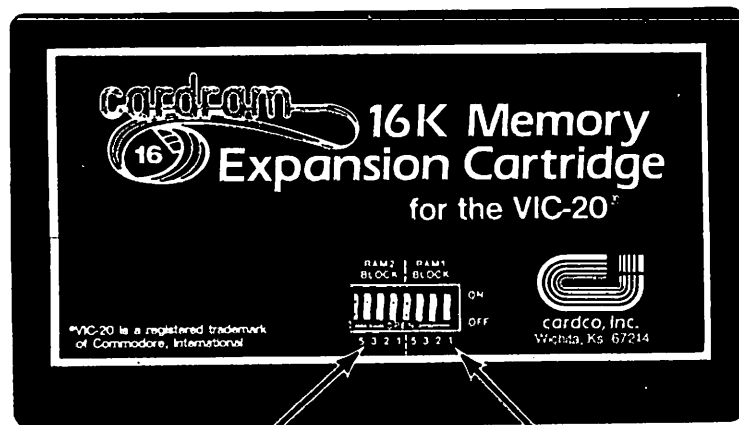
The "CARDAM/16" is the functional equivalent of two separate 8k RAM cartridges, in one cartridge. Each 8k group (or block) can be assigned to any of the four 8k RAM expansion areas that are available in the VIC-20. If you don't understand what I just said return to page 6 and read that section again.

The block assignments are shown on the case of the "CARDAM/16". (see page # 14). You can turn blocks off and on with power on on the computer so as to allow physically moving memory from one location to another.

For example if you had used the program on page # A3 to relocate the screen and basic, then you loaded in a basic program (the program must be less than 8k long) with the "CARDAM/16" RAM 1 BLOCK 1 switch on and all other switches off. You could then switch off RAM 1 BLOCK 1 (this makes that block of memory unavailable to the computer, but leaves it intact), switch on RAM 2 BLOCK 1 and load another basic program into it. Now you can switch back and forth between two basic programs in memory by simply turning one off, turning the other one on and pressing the run/stop and restore keys at the same time. Word of caution - Do not attempt to switch the switches while a program is running. Stop or break the program before switching the switches.

Another example of switching memory is used with the program on page # A16, in which you will actually move a machine language program from BLOCK # 3 to BLOCK # 5 where it needs to be to run correctly.

To do this all you need to do is turn off the applicable switch, then turn on the switch for the RAM area that you wish to put that block of memory in. So the "CARDAM/16" allows you almost unlimited use of memory in the VIC-20. You can use three or more 16k cartridges by simply selecting on or off the ones you need at a given time.



CONTROLS WHICH AREA  
IN THE VIC MEMORY  
RAM 2 (8K BLOCK)  
WILL BE ASSIGNED TO

CONTROLS WHICH AREA  
IN THE VIC MEMORY  
RAM 1 (8K BLOCK)  
WILL BE ASSIGNED TO

MEMORY MAP  
\*\*\*\*\*

This program will simply tell you (by a graphic display on the screen) what memory configuration is present in your computer at any time. To use this program you should not have any program in memory as some of the program could be altered. (However programs in an unexpanded VIC may use this program as a gosub routine) Enter the program (making note of the REMs at the end of the program to assist you in entering the proper characters) as written for use as a gosub in an unexpanded VIC. To use this as a stand alone program change the RETURN in line 10380 to an END.

Now SAVE the program for future use. Run the program and it will display the complete memory allocation of your VIC it will even tell you if you have external games, extra RAM, or empty memory blocks that you can use for future expansion.

The program will also show you where your screen RAM is located, and where basic program RAM area starts. You can then compare this directly with the memory maps that appear in this manual. Try different configurations of memory and actually see on the screen what is happening inside your VIC.



```

100 REM BASIC PROGRAM SWAP BY BRECK RICKETTS
110 M=41216:PRINT"(SC)LOADING(CD)"
120 READA:IFA<0THEN140
130 POKEM,A:M=M+1:B=B+A:GOTO120
140 IFB=25096THENPRINT"GOOD LOAD":GOTO160
150 PRINT"BAD DATA STATEMENTS":END
160 PRINT"(CD)SYS 41216 TO ENABLE":NEW
170 DATA120,169,104,141,20,3,169,161,141,21,
3,120,169,0,133,0,169,16,133,1,169,0,133,2
180 DATA169,163,133,3,169,0,168,177,0,145,2,
230,2,230,0,208,246,230,3,230,1,165,1,201
190 DATA30,208,236,234,165,45,141,0,162,165,
46,141,1,162,165,47,141,2,162,165,48,141,3
200 DATA162,165,49,141,4,162,165,50,141,5,162
,165,51,141,6,162,165,52,141,7,162,165,53
210 DATA141,8,162,165,54,141,9,162,88,96,234,
165,203,201,39,240,4,234,76,191,234,120,32
220 DATA159,255,165,203,201,39,240,247,169,0,
133,0,133,2,168,170,169,16,133,1,169,163
230 DATA133,3,177,0,170,177,2,145,0,138,145,
2,230,2,230,0,208,240,230,3,230,1,165,1
240 DATA201,30,208,230,234,182,45,185,0,162,
153,45,0,138,153,0,162,200,192,10,208,239
250 DATA234,169,147,141,119,2,169,76,141,120,
2,169,201,141,121,2,169,13,141,122,2,169,4
260 DATA133,198,88,76,191,234,-1

```

SPECIAL TERMS AS USED IN THIS MANUAL  
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MEMORY BLK:

Or Memory Block, is a group of memory locations. For our usage in this text, we will refer to a BLK as a group of 8k ( 8k = 8192 ) memory locations.

PORT:

A point at which the internal workings of a computer can send information to or receive information from the outside world. The VIC-20 has several "PORTS" including the USER PORT, the GAME PORT and the MEMORY EXPANSION PORT. (also see slot)

RAM:

Random access memory (RAM for short) is the type of memory that you will use to store your programs. It is "volatile", which means it can be erased. It can be changed or altered, as you wish. For example, if you poke a RAM location (POKE 4099,117), then peek at it (? PEEK (4099)), you will get back what you put in. But if you turn power off and on again, your number will be gone. So RAM changes as you instruct it to store your programs and data.

ROM:

Read Only Memory, (ROM for short), is the opposite of RAM in that it cannot be erased or modified by you and your VIC. ROM is used to store pre-programmed games and utilities. For example, there are ROMs inside your VIC-20 that contain the entire basic language you use for programming. Other programs like the VIC "PROGRAMMERS AID" cartridge come to you on ROMs. Any program that comes in a plug-in cartridge format will be in ROM. These ROMs will take up space in your VIC's available memory. For example, a ROM might be assigned by its designer to work in BLK 5. If you have anything in that block, it will have to go.

SLOT:

In normal use a slot is the same as a port. For our use in this manual we will intend a slot to mean one of the three female connectors (where you plug in cartridges) on the "CARDBOARD/3". These are the electrical equivalent of the "MEMORY EXPANSION PORT" in the rear of your VIC-20

PROGRAM SWAPPER  
\*\*\*\*\*

This program also uses RAM memory in BLK # 5 and your system should be set up as in the last example. In this program we will allow you to store two basic programs in RAM BLK # 5. and call either one for use when ever you need it. There are several limitations to this program due to the limited amount of space available in this manual, however it could be expanded to eliminate all of these limitations.

The programs you intend to use must be able to run on an unexpanded VIC-20. And you must be sure not to have any RAM memory in BLK # 1. To use this program just do the following:

- 1 - Type in the program as shown.
- 2 - Save the program for future use.
- 3 - Run the program.
- 4 - Type SYS 41216 (RETURN)
- 5 - Load or type in your first program.
- 6 - Press function key "F-1"
- 7 - Load or type in your other program.

You now have two basic programs in memory. You can run, edit, save or whatever either program. To swap to the other program all you need to do is press the "F-1" key. For example, you can write your programs to poke variables into unused areas of memory and leave them for the other program to retrieve, and lots of other cute tricks. So here is a good chance for you to use your imagination and experiment a bit.

MACHINE LANGUAGE SCREEN SWAP PROGRAM  
\*\*\*\*\*

```
10 REM E.J. LIPPERT II
20 X=48896
30 READ A: IF A=300 THEN GOTO 50
40 POKE X,A : X=X+1: GOTO30
50 POKE 36879,110:PRINT "CLR/HOME
  CTRL/WHITE"
60 Get A$: IF A$ = "" THEN 60
70 IF A$ <> CHR$(133) THEN PRINT A$;:GOTO60
80 IF P=1 THEN P=0: SYS 48936: GOTO 60
90 P=1: SYS 48896: GOTO 60
100 DATA 162,0,189,0,30,157,0,161,232,208
110 DATA 247,189,0,31,157,0,162,232,208,247
120 DATA 189,0,163,157,0,30,232,208,247,189
130 DATA 0,164,157,0,31,232,208,247,96,234
140 DATA 162,0,189,0,30,157,0,163,232,208
150 DATA 247,189,0,31,157,0,164,232,208,247
160 DATA 189,0,161,157,0,30,232,208,247,189
170 DATA 0,162,157,0,31,232,208,247,96,300
```

NOTE: This program can be expanded to store several screens and can use a for/next loop to do the swap instead of the function key.

APPENDIX OF USEFUL INFORMATION  
\*\*\*\*\*

PROGRAM TO RELOCATE THE SCREEN

By: E.J. Lippert II

```
10 POKE 8192,00
20 POKE 44,32
30 CLR
40 POKE 648,30
50 POKE 36866,150
60 POKE 36869,240
70 FOR I = 217 TO 228:POKE J,158:NEXT
80 FOR I = 229 TO 250:POKE I,159:NEXT
90 PRINT "CLEAR/HOME"
99 NEW
```

NOTE: This program must stand alone. It cannot be part of another program.

THE USE OF RAM MEMORY IN BLK 5  
\*\*\*\*\*

Even if BLK 5 cannot be accessed by basic for programming, it can be a very useful warehouse for data. For example, you can peek at each location of the screen RAM and poke the entire screen into BLK 5 for safekeeping and recall it at any time. You can do this with the screen color RAM, too! There is enough room in BLK 5 to store 16 complete screens, or 8 screens with color information. This can be done with simple basic programming. However, if you used a machine language sub-routine to store and recall the screen, it would happen so fast that you wouldn't even see it change. This is how some arcade games achieve animation.

BLK 5 can be used to store any kind of data. In a program I wrote recently, which was to be used as a message center, each message was stored in BLK 5 and then retrieved as it was requested by the program. The messages could then be changed at will without alteration to the basic program. This also allowed over 8000 bytes of message storage without using any of the VIC-20's valuable basic programming area.

But remember..the only access to BLK 5 is through the basic PEEK/POKE commands, or machine language programming. In fact, the entire 8k can be used to store machine language programs and/or sub-routines. And that is exactly what the VIC Super-Expander cartridge is...it is a bunch of machine language sub-routines (in ROM) stored in BLK 5.

The following programs will demonstrate some uses of BLK 5 RAM. The first will swap and store two screens of information. Set up requires that the "CARDRAM/16" have one 8k RAM BLOCK assigned to BLK 5 (dip switch #5 on). The other block switches may be off or selected to any block other than block # 5.

Press reset, enter (and save on tape or disk) the program as shown. Load and run the program. Type in something then press the "f-1" function key. The screen will show garbage. Clear the screen, and type in some more information. Now press the "f-1" key again, and you will see what you typed in on the first screen. The "f-1" key is now a switch to go from one screen to another. This system can be used for as many as 16 screens using just BLK 5. And if you are a real perfectionist you can use the same process to store the color information from it's location at 37888 into BLK # 5 along with the screen RAM data.